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SELF CURRENT LIMITING
BI-DIMENSIONAL RESISTIVE CATHODE WIRE CHAMBERS

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ABSTRACT

A proportional wire chamber using highly resistive cathodes of In-Sn oxide film on mylar sheets was constructed. Induced positive signals were detected by printed circuit copper strips on the outside of the mylar sheets. Centroid readout of the pulses from the strips provides the second coordinate with an accuracy of better than 100 μ on the average. The resistive film cathodes may limit spark or corona current which can be destructive and may also provide continuous potential gradient for drift chambers.

INTRODUCTION

Bi-dimensional high resolution proportional wire chambers using centroid readout of induced pulses from cathodes have been reported.[1)] In this case, cathode wires were looked at directly. Recently, a group[2)] obtained a second coordinate from a proportional tube reading induced pulses through a helical winding which was capacitively coupled to a resistive cathode. In this, the helical line was lossy (attenuation factor of 5 in 2.5 m length), and spatial resolution was obtained to be FWHM = 1.8 cm for limited streamer pulses.

This report describes a chamber (the idea was suggested by the Laboratory Director, Dr. L. Lederman) which provides high spatial resolutions using the induced pulses indirectly read out by the strips outside, as shown in Fig. 1. As will be seen from the data that there is no loss in the resolution of the centroid readout by this method which provides current limiting, a convenient way for connecting pads or strips to amplifiers and may also provide continuous potential gradient for drift chambers. Spark or corona discharge has been very damaging in proportional wire chambers and drift chambers. Such damages can be reduced or prevented by choosing a resistive film with proper resistance depending on rate requirements.

The test chamber had 3 mm anode wire spacing and a cathode to anode gap of 3.5 mm with an active area of 15 x 15 cm^2. The width of the strips was 5 mm. It was built as a multiwire proportional chamber for measuring spatial resolutions and pulse height uniformity by reading the pulse heights obtained from the strips outside. Fig. 1 shows a magnified cross section of the cathode structure. The induced positive signals on the In-Sn[3)] oxide cathode film (20 KΩ per square) are capacitively coupled to the printed circuit copper strips. Each strip gets a portion of the induced signal. The size of the portion is a function of the distance from the avalanche point. Centroid of the positive pulse height distribution provides the avalanche coordinate along the anode wire.

PRELIMINARY MEASUREMENTS

A narrowly collimated Fe^{55} source was used for the tests. The gas mixture was 50 percent argon-50 percent ethane. The source was moved in steps for each centroid measurement to a precision of better than 10 microns using a dial indicator. The pulse height obtained from each strip within the vicinity of the collimated source was recorded in succession by LeCroy QVT 3001 analyzer. The QVT was gated using the anode signal with a gate width of 100 nsec.

An inverting current amplifier was used for receiving the pulses. The input impediance of the amplifier was 85 ohms. The 5.9 KeV pulses from an anode wire and an associated strip are shown in Figs. 2a and 2b, respectively. The chamber was operated in the proportional mode during the entire test as indicated in Fig. 3. The gain factor was around 3×10^3. The pulse height resolution was about 16 percent for the 5.9 KeV line, and there is a small loss from the resolution in receiving the pulses by the cathode strips outside.

Fig. 4 shows a typical pulse height distribution obtained from the associated strips. Each point represents the peak pulse height resulted from the 5.9 KeV line of the Fe^{55} spectrum. The centroids of the pulse height distributions obtained from the strips are plotted against the measured source positions (Fig. 5). It shows that the linearity is excellent, and the average deviation from the fitted straight line is less than 100 microns.

The areas under the centroid distributions (as shown in Fig. 4) were integrated and plotted against the source positions (Fig. 6). It indicates that total pulse height stays quite uniform as the source is moved. An average pulse height uniformity of better than a few percent is obtainable from the strips outside through a resistive cathode film of 20 percent uniformity using a gate width of 100 nsec. The measurements do not carry any corrections related to resistive variations in the film, temperature, or pressure changes during several days of data taking.

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REFERENCES

1. Breskin et al., Nucl. Instr. and Meth. 143 (1977) 29.

2. G. Battistoni, et al., Nucl. Instr. and Meth. 152 (1973) 423.

3. The resistive films were provided by the Sierracin Company. Film resistivities of a few ohms to a megaohm per square can be obtained.

FIGURE CAPTIONS

Fig. 1	A schematic view of the chamber.
Figs. 2a and 2b	5.9 KeV pulses from an anode wire and an associated strip, respectively.
Fig. 3a	5.9 KeV pulse height spectrum obtained from an anode wire. 5.9 KeV line and 2.9 KeV argon escape line are seen.
Fig. 3b	5.9 KeV pulse height spectrum obtained from a strip. 5.9 KeV line and argon escape line are shown.
Fig. 4	Peak pulse height distribution of 5.9 KeV line obtained from the neighboring strips.
Fig. 5	Centroid positions versus source positions.
Fig. 6	Integrated pulse heights from the strips plotted against source positions.

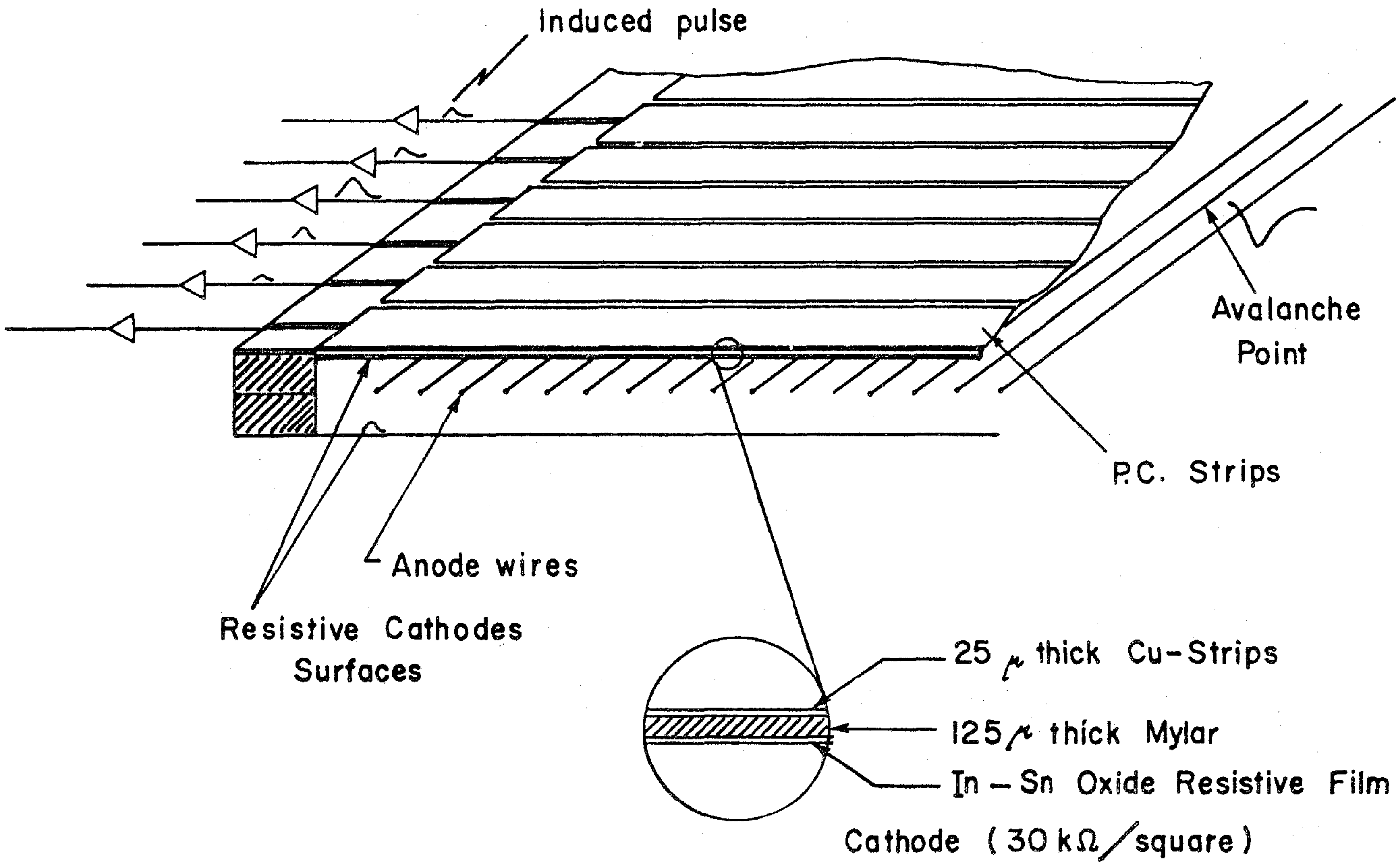
Induced pulse
Avalanche Point
P.C. Strips
Anode wires
Resistive Cathodes Surfaces
25 μ thick Cu-Strips
125 μ thick Mylar
In – Sn Oxide Resistive Film
Cathode (30 kΩ/square)

Fig. 1

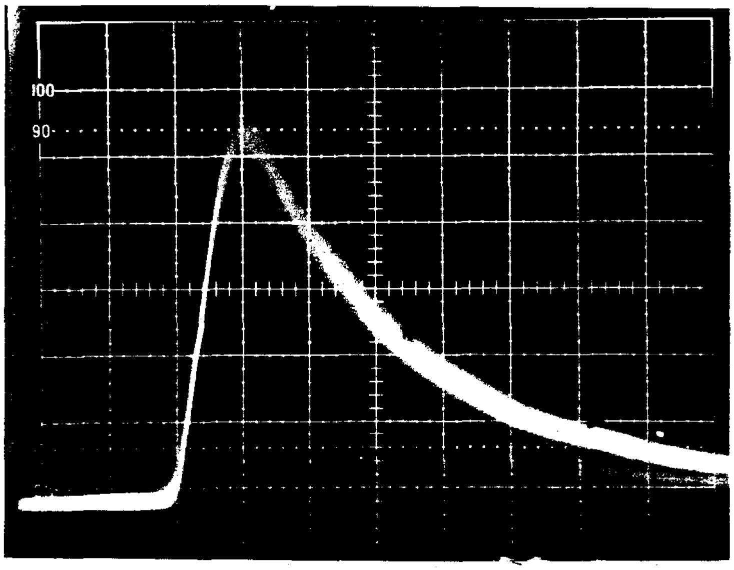

Fig. 2a 20 ns/div

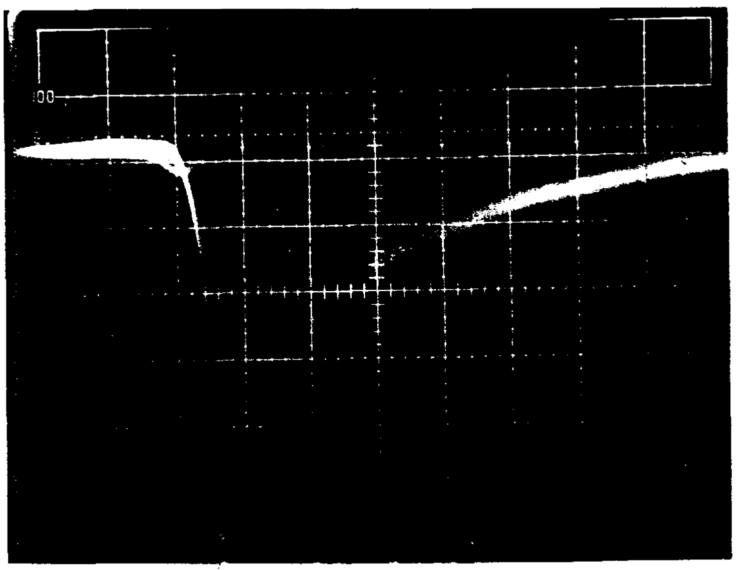

Fig. 2b

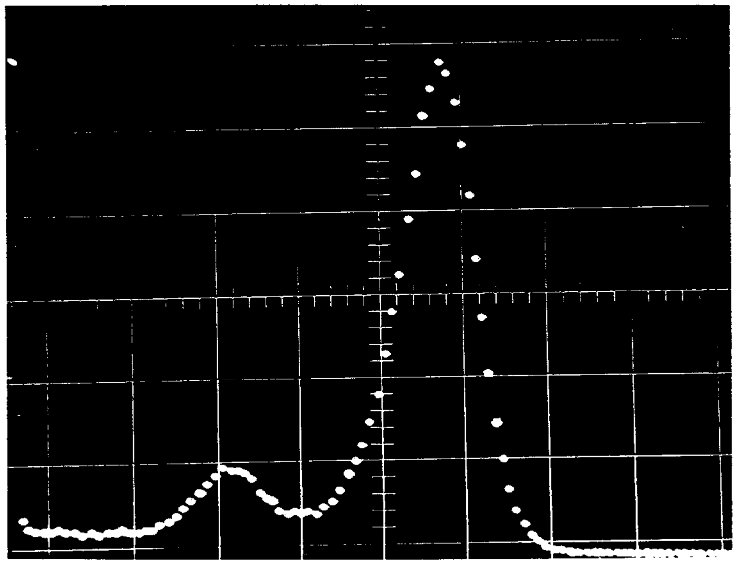

Fig. 3a

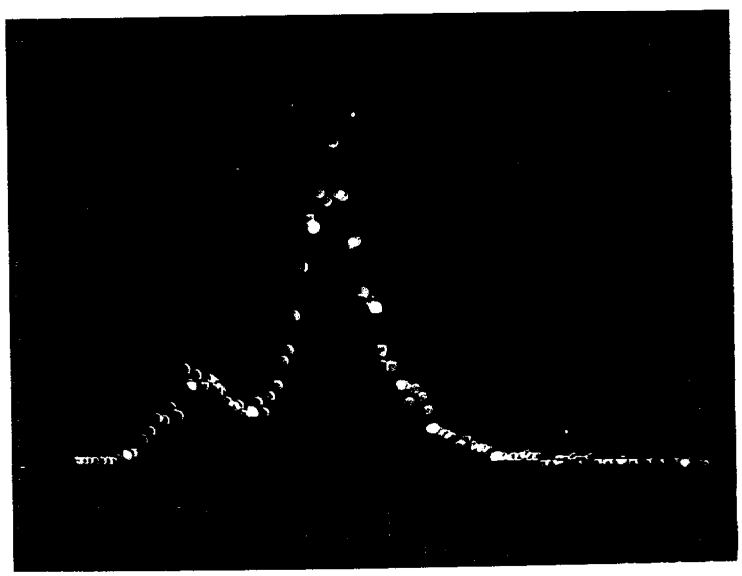

Fig. 3b

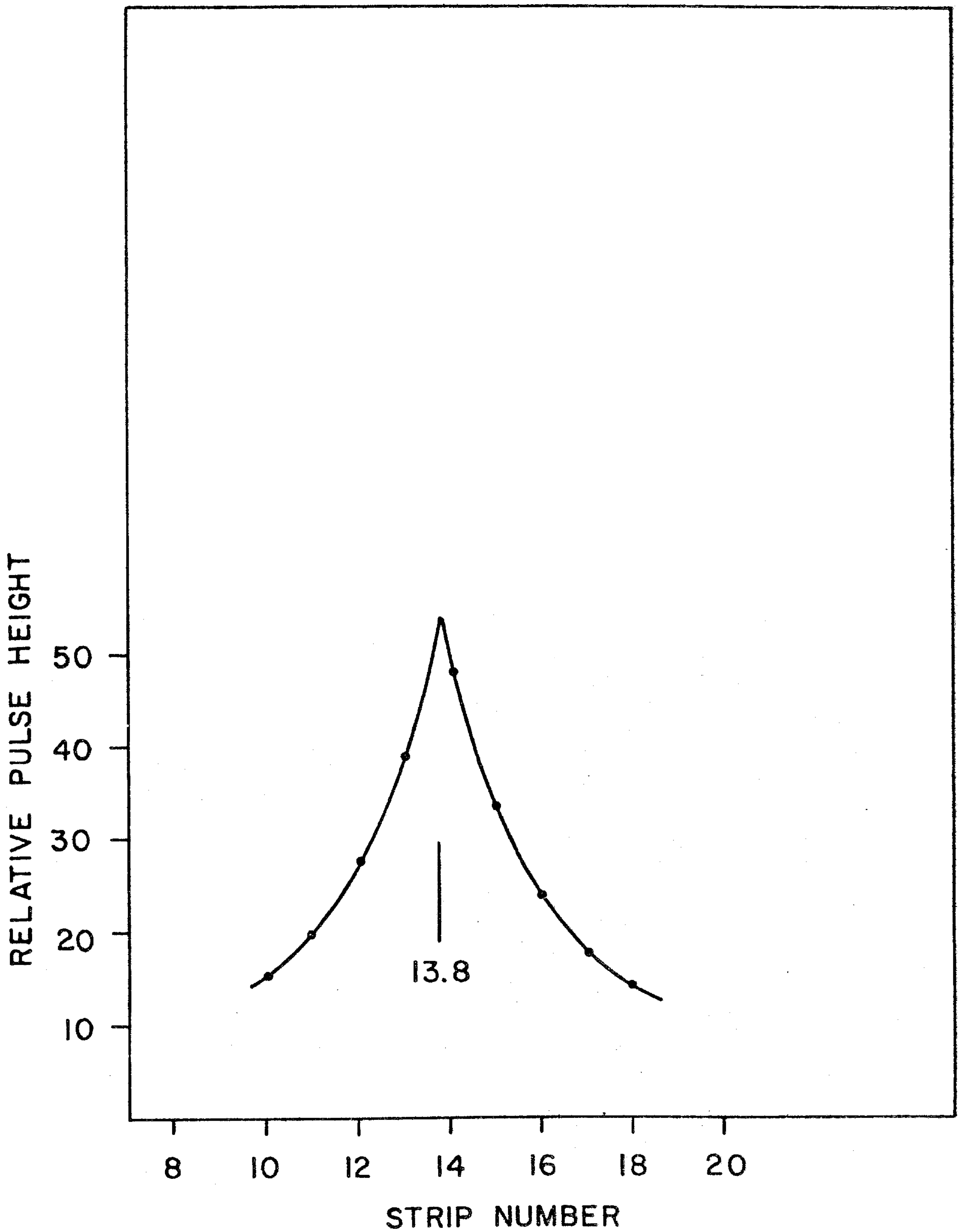
RELATIVE PULSE HEIGHT
10
20
30
40
50
8
10
12
14
16
18
20
STRIP NUMBER
13.8

Fig. 4

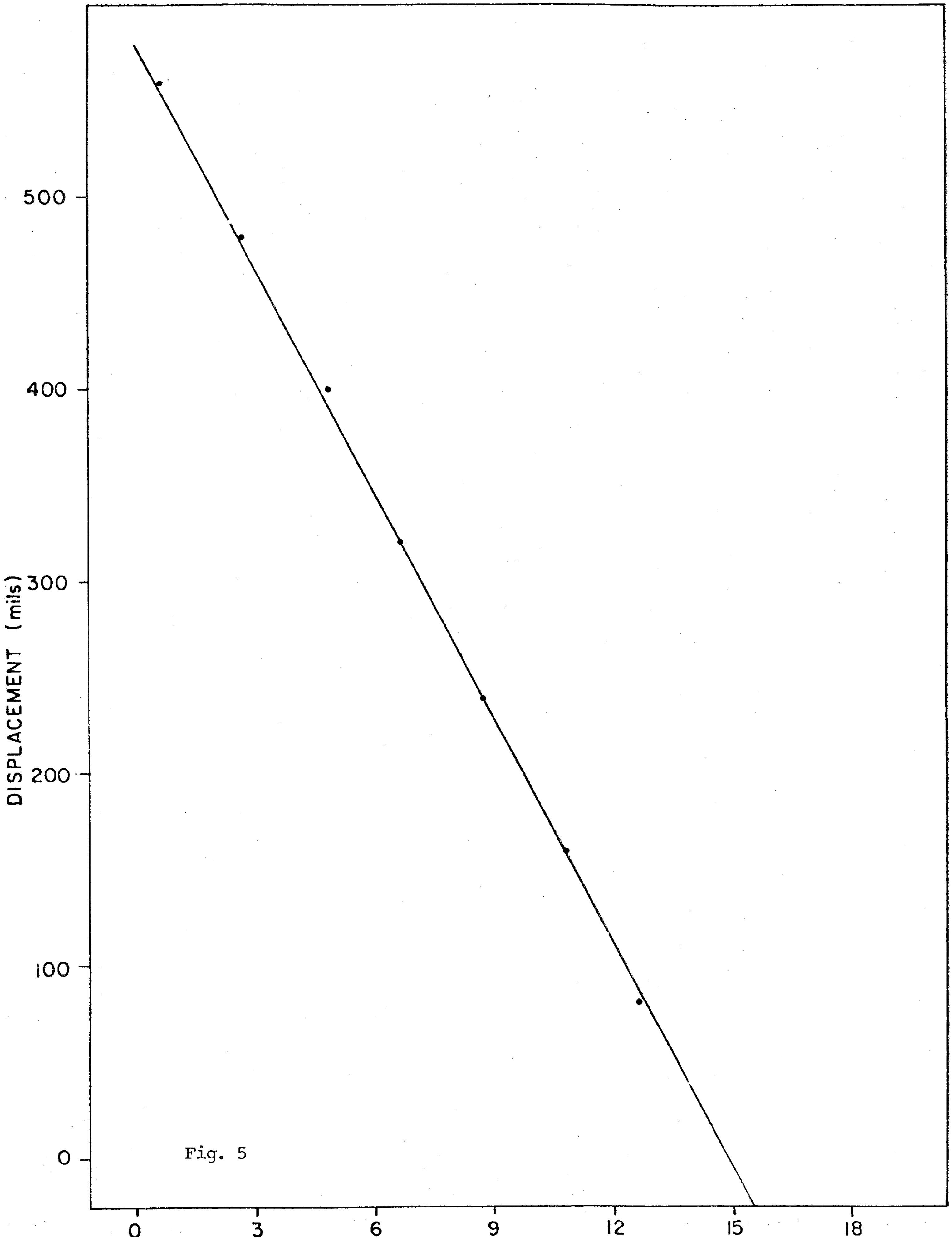

Fig. 5

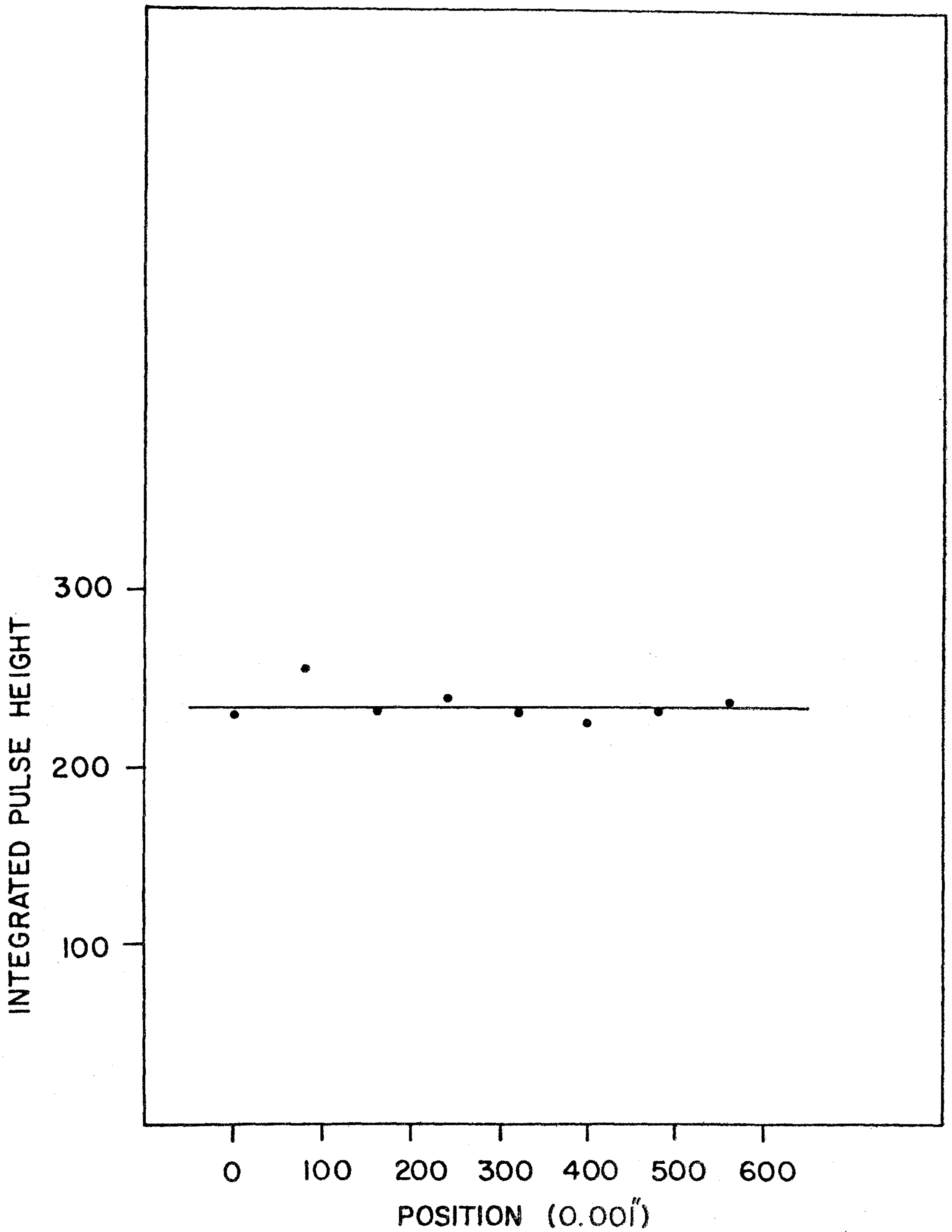
300
200
100
INTEGRATED PULSE HEIGHT
0
100
200
300
400
500
600
POSITION (0.001")

Fig. 6